### OCTOBER 2019





WIM #33 US 212, MP 78.5 OLIVIA, MN

MONTHLY REPORT



Your Destination...Our Priority

















#### WIM Site Location

WIM #33 is located on US 212 near Olivia in Renville county.

#### **System Operation**

WIM #33 was operational for the entire month of October 2019. Volume was computed using all monthly data.

#### **System Calibration**

WIM #33 was most recently calibrated on 2015-06-17. Table 1 summarizes the front axle weights of class 9s by lane <sup>1</sup>. Figure 1 shows the distribution of gross vehicle weights (GVW) in Class 9 vehicles at this site for the last 12 months of operation <sup>2</sup>. Figure 2 depicts the average front axle weight as a percent difference from the first full month following calibration.

#### **Summary of Volume Statistics**

Total Monthly Volume: 164055 | Passenger Vehicles: 135502 | Heavy Commercial

Vehicles: 28553

Monthly Average Daily Traffic (MADT): 5262 | Monthly Heavy Commercial Average Daily

Traffic (MHCADT): 921

See Table 2 for vehicle class breakdown

#### Passenger Vehicles (PVs) and Heavy Commercial Vehicles (HCVs)

**Volume trends.** EB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Saturdays. WB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Saturdays (see Figure 3 and 4).

#### Passenger Vehicles (PVs)

**Volume trends.** On an average 24-hour day (see Figure 5), EB PVs generally reached peak volume levels between 03 PM and 05 PM. Similarly, WB PVs peaked in volume between 03 PM and 05 PM

#### **Heavy Commercial Vehicles (HCVs)**

**Volume trends.** On an average 24-hour day, HCVs traveling EB typically reached peak volume levels between 03 PM and 05 PM, while volume going WB peaked between 03 PM and 05 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 9's and Class 5's.

#### **Overweight HCVs**

**Volume trends.** Of a total of 28553 HCVs, 5350 of them were overweight <sup>3</sup>. These overweight HCVs contributed to 2.3% of total monthly volume, and 13.2% of total monthly

HCV volume. EB overweight vehicles typically reached highest numbers on Mondays, with lowest volumes reported on Saturdays. WB overweight vehicles tended to reach highest volumes on Tuesdays, with lowest volumes reported on Saturdays. See Figure 3 . The top two overweight violators by class were the class 13 and class 9 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 74% of all overweight vehicles traveling WB this month (see Figure 7 & 8). Figure 9 shows the number of vehicles exceeding 88,000 pounds that crossed the WIM over the last 12 months. The highest number of 88,000+ vehicles within the last 12 months occurred in January.

WIMs are currently used as a screening tool for weight enforcement, and it is estimated that the WIM scales can measure gross vehicle weights (GVW) within 90-95% of static weight scale measurements. Due to the possibility of measurement error, vehicles exceeding 10% of their legal weight limits (or 1.1 times their legal weight limits) are considered overweight in this report <sup>4</sup>.

Using normal load limits ,224 EB vehicles exceeded 88,000 pounds (175 vehicles were Class 13's; 40 vehicles were Class 10's). Of vehicles traveling WB,

804 EB vehicles exceeded 88,000 pounds (753 vehicles were Class 13's; 43 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from October 2019.

**Loaded vs. Unloaded HCVs.** Figure 10 shows the GVW distributions of Class 9s and 10s in October 2019. Data suggests that there were greater numbers of fully\_loaded Class 9's than empty Class 9's traveling EB, while there were more fully\_loaded Class 9's than empty traveling WB. Data also suggests that there were more empty Class 10's than fully\_loaded traveling in the EB direction. In the WB direction, there were more fully\_loaded class 10 vehicles.

**Freight Totals.** A total of 380597 tons of freight was recorded to have crossed the WIM. More freight was shipped WB (62.8%) than EB (37.2%). See Table 4 and Figure 11 for more freight information.

###Infrastructure Considerations Bridge. Bridge No. 6299 (a box culvert) is approximately 13.4 miles east of WIM #33, and Bridge No. 96640 (a box culvert) is 2.5 miles west of WIM #33. WIM #33 recorded a total of 164055 vehicles with a combined GVW of 2751552 kips (1 kip = 1,000 pounds = 0.5 tons) in October 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

**Pavement Design.** A total of 26139 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 53.6% of all ESALs were recorded WB while 46.4% was observed EB. In particular, 65% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 40% of total GVW observed this month). See Table 6 and Figures 14-15 for more information on ESALs (Table 6 also provides flexible ESAL factors for each vehicle class using a terminal serviceability of 2.5 and a structural number of 5).

#####WIM monthly reports can be found at:

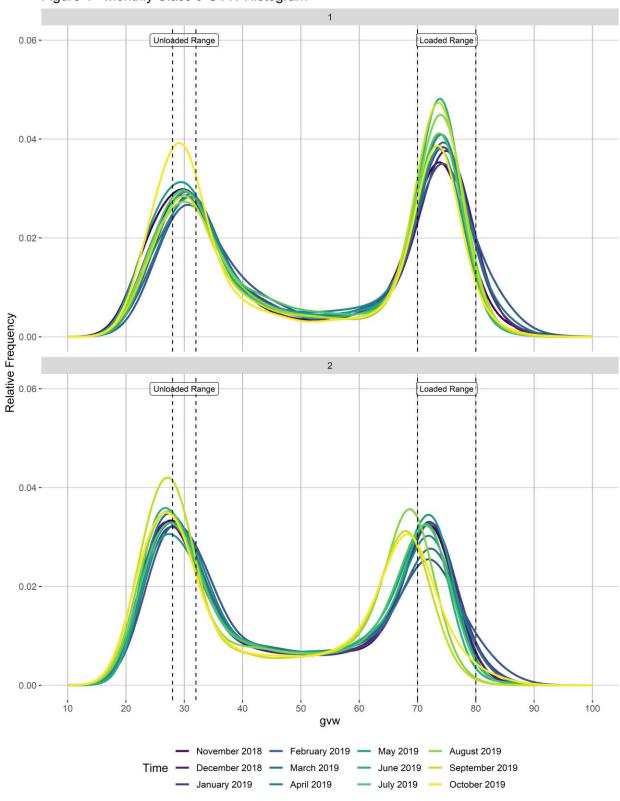
http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html MnDOT's vehicle

classification scheme and vehicle class groupings for traffic forecasting can be found at: http://www.dot.state.mn.us/traffic/data/data-products.html#weight

- <sup>1</sup> Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ?9% of baseline calibration values
- Previous WIM research indicates that unloaded Class 9s typically weigh 28-32 kips, while loaded Class 9s generally fall in the 70-80 kip range. More recent data from several WIM sites suggests that the unloaded Class 9 range may have moved a little higher over time (due to increased presence of sleeper cabs, etc.), although these ranges are also thought to be site-specific.
- <sup>3</sup> An HCV is considered overweight during normal load limits in this report if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 80,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 20,000 pounds; tandem axles spaced 8' or less = 34,000 pounds; tridem axles spaced 9' or less = 43,000 pounds; quad axles spaced 13' or less = 51,000 pounds). Monthly reports use this standard regardless of the time of year however, the Winter Load Increase (WLI) allows a 10% across the board increase in axle and gross vehicle weights without a permit on US, state routes, and county roads. An HCV is considered overweight during Winter Load Increase(WLI) if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 88,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 22,000 pounds; tandem axles spaced 8' or less = 37,400 pounds; tridem axles spaced 9' or less = 47,300 pounds; quad axles spaced 13' or less = 56,100 pounds). An overweight HCV is only included once in the overweight volume calculations regardless of how many of the aforementioned conditions are violated. For information on MN weight limit dates and statutes: http://www.mrr.dot.state.mn.us/research/seasonal\_load\_limits/sllindex.asp
- 4 For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened (e.g., 80,000 lbs + 8,000 lbs = 88,000 lbs). Similarly during WLI vehicles weighing 96,800 lbs should be screened.

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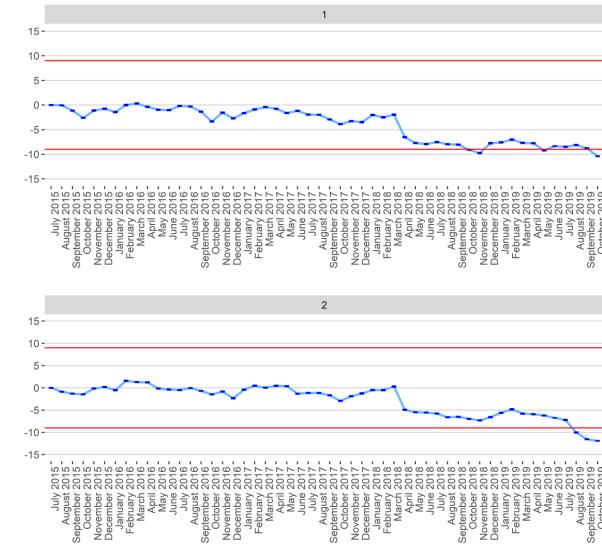
Figure 1 - Monthly Class 9 GVW Histogram



Months that have not passed QC parameters are not displayed

% Difference

Figure 2 - Percent Difference of Front Axle Weight from Last Calibration (+/- 95% CI)



Months that have not passed QC parameters are not displayed

Figure 2 - Average Vehicle Volume vs. Day of the Week

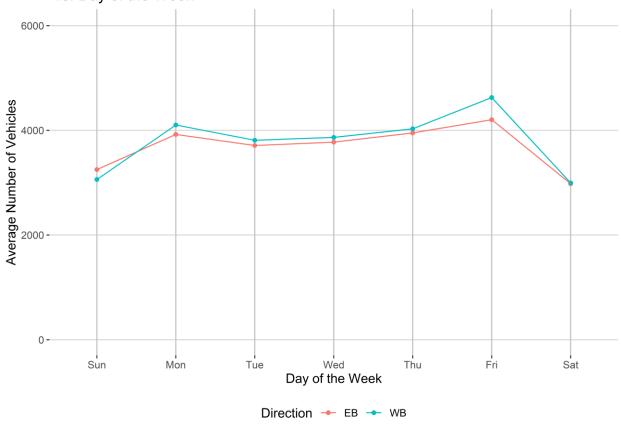
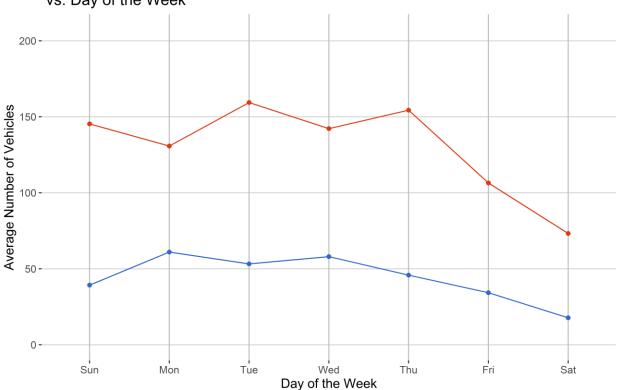


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week



Direction → EB → WB

Figure 4 - Passenger Vehicles vs. Hour of the Day

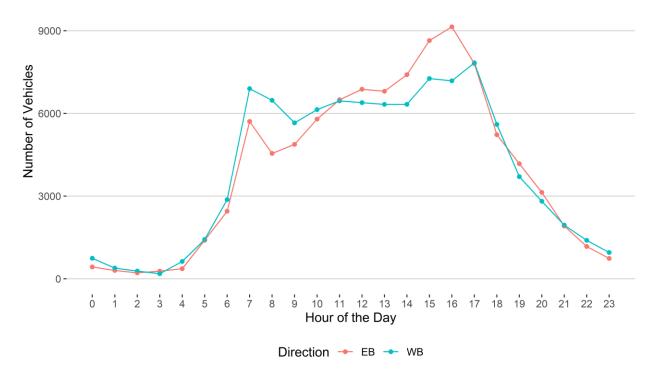


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

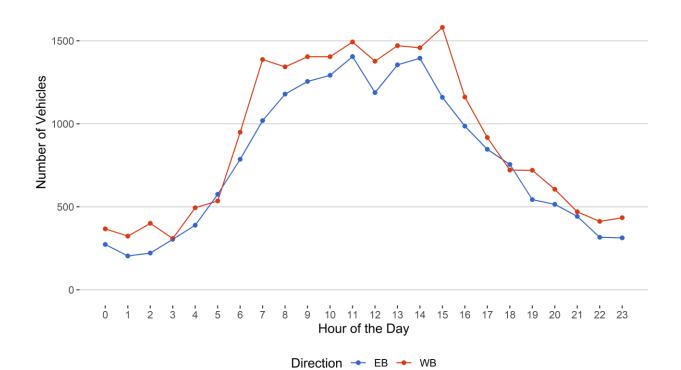


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

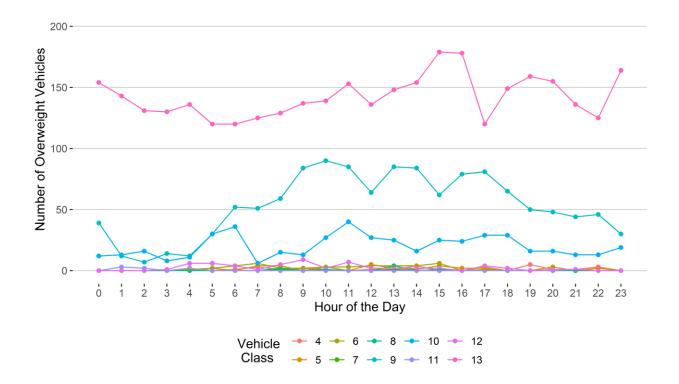


Figure 7 - Overweight Vehicles by Direction Hour of the Day

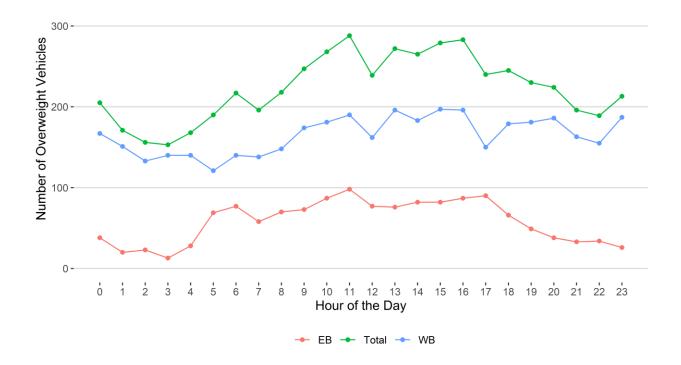
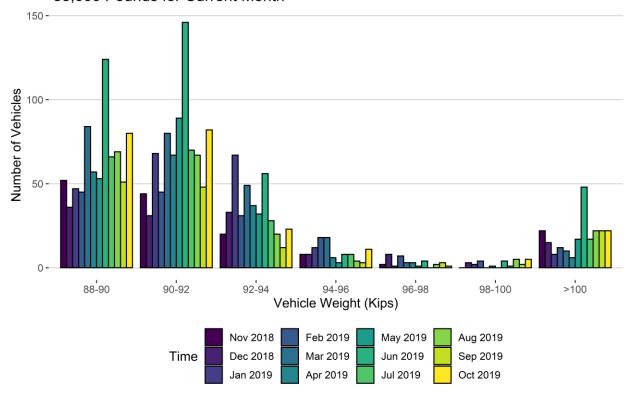
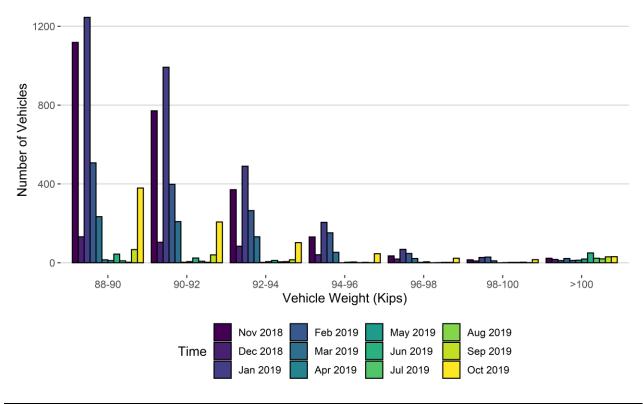


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	Мау 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019	Oct 2019
88-90	52	36	47	45	84	57	53	124	66	69	51	80
90-92	44	31	68	45	80	67	89	146	70	67	48	82
92-94	20	33	67	31	49	37	32	56	28	20	12	23
94-96	8	8	12	18	18	6	3	8	8	4	3	11
96-98	2	8	1	7	3	3	1	4	0	2	3	1
98-100	0	3	2	4	0	1	0	4	1	5	2	5
>100	22	15	8	12	10	6	17	48	17	22	22	22
Total	148	134	205	162	244	177	195	390	190	189	141	224

Figure 8 - Histogram of WB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	Мау 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019	0ct 2019
88-90	1118	132	1245	507	234	15	11	44	10	3	67	379
90-92	771	104	992	398	209	3	6	24	8	3	40	207
92-94	371	84	490	265	132	2	6	12	5	6	15	102
94-96	131	41	205	152	53	0	3	4	1	2	1	46
96-98	35	19	68	47	22	2	5	0	1	2	2	23
98-100	15	9	27	29	10	0	1	2	2	3	1	16
>100	23	17	11	22	12	13	19	50	23	20	30	31
Total	2464	406	3038	1420	672	35	51	136	50	39	156	804

Figure 8 - Class 9's and 10's by Direction vs Gross Vehicle Weight

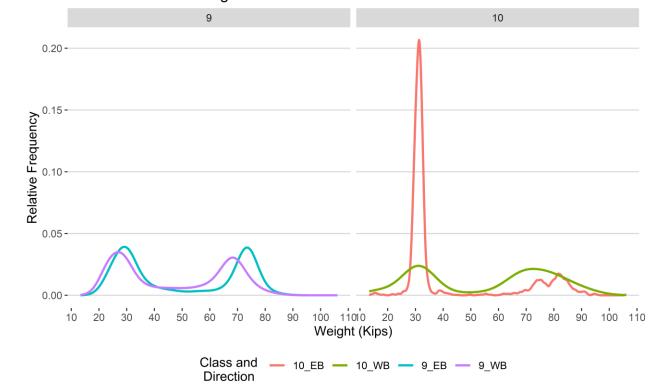


Figure 9 - Freight Percentage by Direction and Class

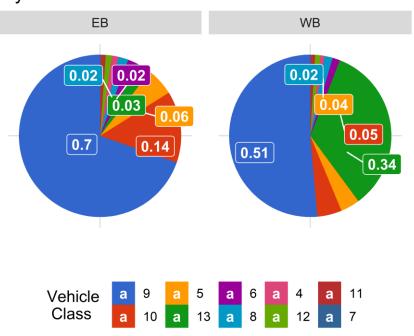


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

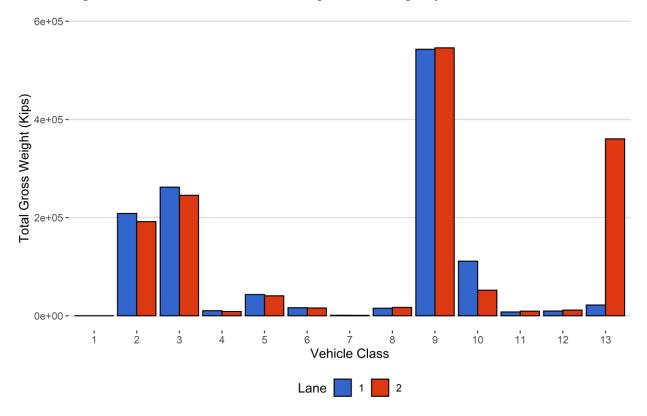


Figure 11 - Total Gross Vehicle Weight k

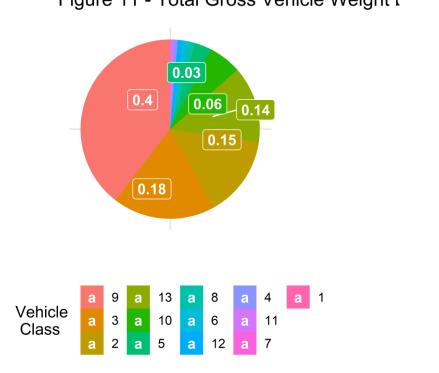


Figure 12 - Total ESALs by Class and Lane

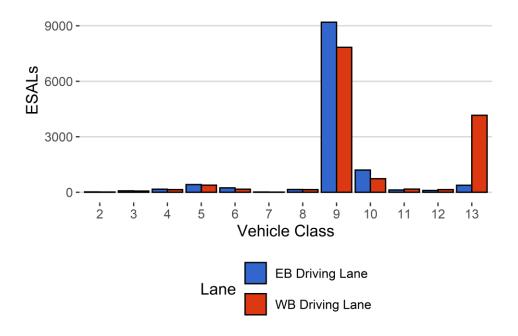
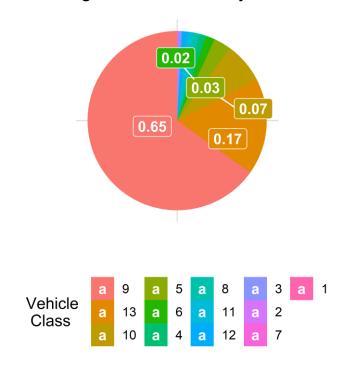


Figure 13 - ESALs by Class



**Table 1 Class 9 Front Axle Weight by Lane** 

Month	Lane 1 (Kips)	Front Axle +/- 9%	Lane 2 (Kips)	Front Axle +/- 9%
July 2015	11.76	0.00	10.98	0.00
August 2015	11.75	-0.07	10.89	-0.88
September 2015	11.62	-1.13	10.84	-1.31
October 2015	11.45	-2.60	10.82	-1.46
November 2015	11.63	-1.12	10.97	-0.15
December 2015	11.67	-0.76	11.00	0.20
January 2016	11.59	-1.44	10.92	-0.53
February 2016	11.76	-0.01	11.16	1.58
March 2016	11.79	0.31	11.12	1.28
April 2016	11.71	-0.37	11.12	1.23
May 2016	11.64	-0.97	10.97	-0.15
June 2016	11.64	-1.04	10.94	-0.39
July 2016	11.74	-0.19	10.93	-0.49
August 2016	11.72	-0.31	10.98	-0.05
September 2016	11.60	-1.36	10.91	-0.69
October 2016	11.36	-3.35	10.82	-1.48
November 2016	11.58	-1.55	10.89	-0.83
December 2016	11.44	-2.72	10.72	-2.35
January 2017	11.56	-1.65	10.94	-0.41
February 2017	11.65	-0.91	11.03	0.47
March 2017	11.71	-0.43	10.99	0.03
April 2017	11.67	-0.77	11.03	0.46
May 2017	11.57	-1.63	11.02	0.37
June 2017	11.62	-1.18	10.84	-1.33
July 2017	11.53	-1.94	10.86	-1.15
August 2017	11.53	-1.98	10.86	-1.15
September 2017	11.41	-2.94	10.80	-1.68
October 2017	11.30	-3.90	10.66	-2.94
November 2017	11.37	-3.28	10.77	-1.89
December 2017	11.35	-3.49	10.84	-1.26
January 2018	11.52	-2.02	10.93	-0.49
February 2018	11.46	-2.50	10.93	-0.52
March 2018	11.53	-1.97	11.02	0.30
April 2018	10.99	-6.53	10.44	-4.92
May 2018	10.85	-7.73	10.38	-5.48
June 2018	10.82	-7.93	10.37	-5.55
July 2018	10.87	-7.53	10.35	-5.78
August 2018	10.82	-7.97	10.26	-6.62
September 2018	10.81	-8.05	10.27	-6.50

October 2018	10.69	-9.08	10.22	-6.98
November 2018	10.61	-9.77	10.18	-7.32
December 2018	10.84	-7.77	10.26	-6.58
January 2019	10.86	-7.59	10.37	-5.61
February 2019	10.93	-7.03	10.45	-4.83
March 2019	10.85	-7.70	10.35	-5.79
April 2019	10.84	-7.77	10.33	-5.92
May 2019	10.67	-9.22	10.30	-6.22
June 2019	10.78	-8.35	10.24	-6.74
July 2019	10.76	-8.49	10.19	-7.23
August 2019	10.80	-8.12	9.88	-10.04
September 2019	10.72	-8.79	9.71	-11.55
October 2019	10.53	-10.42	9.67	-11.91

**Table 2 Vehicle Classification Data** 

Vehicle Class	Monthly Average Daily Volume	Monthly Total Volume	Monthly Total Volume Percentage	Monthly Total Overweight Vehicles	Monthly Total Overweight Percentage
1	1	20	0	0	0
2	2357	73054	44.5	0	0
3	2014	62427	38.1	0	0
4	14	443	0.3	27	0.5
5	138	4287	2.6	34	0.6
6	28	870	0.5	42	0.8
7	1	30	0	2	0
8	27	827	0.5	8	0.1
9	511	15844	9.7	1273	23.8
10	82	2538	1.5	479	9
11	8	237	0.1	8	0.1
12	8	248	0.2	57	1.1
13	104	3229	2	3420	63.9
TOTAL	5292	164055	100	5350	100

Table 3 Top 10 Gross Vehicle Weight, Class 9 and 10

Date	Day of Week	Time	Vehicle Class	Direction	Lane	GVW (lbs)
2019-10-15	Tuesday	10:44:25	9	WB	2	107.82
2019-10-05	Saturday	12:39:08	10	EB	1	106.09
2019-10-05	Saturday	12:39:08	10	EB	1	106.09
2019-10-23	Wednesday	15:04:18	10	WB	2	100.26
2019-10-30	Wednesday	01:16:24	10	WB	2	96.98
2019-10-21	Monday	07:31:07	10	WB	2	96.47
2019-10-23	Wednesday	13:35:23	10	EB	1	95.76
2019-10-21	Monday	06:06:44	10	EB	1	95.13
2019-10-28	Monday	14:56:04	10	EB	1	94.77
2019-10-23	Wednesday	04:30:00	10	WB	2	94.75

**Table 4 Freight Summary** 

Vehicle Class	Direction	Weight of Empty Vehicle (Kips)	Total Number of Vehicles	Number of Empty Vehicles	Percentage of Empty Vehicles	Total Weight of Vehicles with Freight (Kips)	Total Weight of Empty Vehicles (Kips)	Total Weight of Freight (Tons)
4	EB	15	326	37	11.3	9848	488	2756
5	EB	8	3049	351	11.5	40656	2581	9536
6	EB	19	603	195	32.3	13114	3211	2681
7	EB	11.5	19	0	0	1046	0	414
8	EB	31	561	407	72.5	5801	9533	514
9	EB	33	10907	4444	40.7	418473	124597	102597
10	EB	33.5	2660	1952	73.4	51005	60158	13644
11	EB	36.5	164	43	26.2	6243	1411	913
12	EB	36.5	176	7	4	9369	235	1600
13	EB	31.5	250	8	3.2	21586	243	6981
TOTAL	****	****	18715	7444	****	577142	****	141637
Vehicle Class	Direction	Weight of Empty Vehicle (Kips)	Total Number of Vehicles	Number of Empty Vehicles	Percentage of Empty Vehicles	Total Weight of Vehicles with Freight (Kips)	Total Weight of Empty Vehicles (Kips)	Total Weight of Freight (Tons)
4	WB	15	301	59	19.6	7961	747	2165
5	WB	8	3024	535	17.7	36824	3828	8456
6	WB	19	630	183	29	12929	2959	2218
7	WB	11.5	23	0	0	883	0	309
8	WB	31	611	436	71.4	6492	10496	533
9	WB	33	11538	4706	40.8	421329	124534	97936
10	WB	33.5	936	324	34.6	42845	9172	11171
11	WB	36.5	172	8	4.7	9132	216	1573
12	WB	36.5	175	4	2.3	11361	89	2560
13	WB	31.5	4325	0	0	360315	0	112039
TOTAL	****	****	21735	6255	***	910069	****	238961
GRAND TOTAL	***	****	40450	13699	495	1487211	354497	380597

Table 5 Gross Vehicle Weight by Class and Lane

Vehicle Class	EB	WB	Total	Percentage
1	25	16	41	0
2	208463	191737	400200	14.6
3	262088	245494	507582	18.5
4	10336	8708	19044	0.7
5	43237	40651	83888	3.1
6	16325	15888	32213	1.2
7	1046	883	1929	0.1
8	15334	16988	32322	1.2
9	543070	545863	1088933	39.6
10	111164	52017	163181	5.9
11	7654	9347	17001	0.6
12	9605	11450	21055	0.8
13	21829	360315	382143	13.9
TOTAL	1250176	1499356	2749532	100
GVW/LANE	45.47	54.53	100	0

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

Vehicle Class	EB	WB	Total	Percentage	Flexible ESAL Factor
1	0	0	0	0	0.0333
2	24	19	43	0.2	8e-04
3	81	67	148	0.6	0.0034
4	170	145	315	1.2	1.01
5	416	388	804	3.1	0.27
6	241	171	412	1.6	0.67
7	16	10	27	0.1	1.24
8	155	148	303	1.2	0.52
9	9190	7835	17025	65.2	1.52
10	1205	737	1941	7.4	1.08
11	125	172	298	1.1	1.75
12	103	147	250	1	1.42
13	383	4161	4544	17.4	1.99
TOTAL	12110	14000	26110	100	12
ESALS/LANE	46.4	53.6	100	_	_

**Table 7 Site Summary: Volume and Vehicle Class** 

Month	Total Volume	Monthly ADT	Monthly HCADT	Passenger Vehicles	Passenger Vehicles %	Heavy Commercial Vehicles	Heavy Commercial Vehicles %
Nov 2018	159326	5311	1002	129266	81.1	30060.4	18.9
Dec 2018	137277	4576	562	119844	87.3	17433.5	12.7
Jan 2019	136631	4407	857	110055	80.5	26575.5	19.5
Feb 2019	114260	4081	721	94070	82.3	20190.2	17.7
Mar 2019	138776	4477	648	118679	85.5	20096.7	14.5
Apr 2019	140330	4678	641	121113	86.3	19216.6	13.7
May 2019	162937	5174	679	141887	87.1	21050.5	12.9
Jun 2019	156866	5229	642	137597	87.7	19269.2	12.3
Jul 2019	159420	5102	597	140916	88.4	18504.3	11.6
Aug 2019	169242	5447	713	147124	86.9	22117.7	13.1
Sep 2019	152884	5138	780	129490	84.7	23393.9	15.3
Oct 2019	164055	5262	921	135502	82.6	28553.2	17.4
TOTAL	1792004	-	-	1525543	-	266462	-
AVERAGE	149334	4907	730	127129	85	22205	15

### ###ESALs

Month	ESALS EB Driving Lane	ESALS WB Driving Lane	Total ESALS	Pavement Life Decrease Months
Nov 2018	8223	12550	20773	3
Dec 2018	6326	6234	12560	2.5
Jan 2019	7551	12934	20486	3.3
Feb 2019	7266	8726	15992	3.6
Mar 2019	7505	7468	14973	2.2
Apr 2019	7081	5767	12848	0.6
May 2019	7030	6625	13655	0.7
Jun 2019	14609	11559	26168	1
Jul 2019	7391	4814	12205	1.8
Aug 2019	8503	6385	14889	2.2
Sep 2019	8209	6482	14690	0.9
Oct 2019	12116	14023	26139	1.7
TOTAL	101811	_	-	-
AVERAGE	8484	8631	17115	2

## ###Gross Vehicle Weight

Month	GVW EB Driving Lane	GVW WB Driving Lane	Total GVW Kips
Nov 18	876238	1195186	2071423
Dec 18	663511	704078	1367589

AVERAGE	856835	939842	1796677	
TOTAL	10282024	11278098	21560122	
Oct 19	1250632	1500920	2751552	
Sep 19	806828	821209	1628037	
Aug 19	836256	809778	1646034	
Jul 19	779280	638532	1417812	
Jun 19	1512692	1451859	2964551	
May 19	771941	774947	1546888	
Apr 19	705844	678545	1384390	
Mar 19	705802	775079	1480881	
Feb 19	624281	797364	1421645	
Jan 19	748717	1130601	1879318	

# ###Overweight Vehicles

Month	Total Number of Overweight Vehicles	Overweight / Total Volume	Overweight / Heavy Commercial Volume	Number Over 88,000 lbs	Number Over 98,000 lbs
Nov 2018	6184	3.9	20.7	2613	60
Dec 2018	1711	1.2	9.6	540	44
Jan 2019	6767	5	25.7	3243	48
Feb 2019	4196	3.8	21.2	1582	67
Mar 2019	2644	1.9	13.3	916	32
Apr 2019	1066	0.8	5.6	213	20
May 2019	1059	0.7	5.1	246	37
Jun 2019	2304	0.7	6	528	106
Jul 2019	1055	0.7	5.9	240	43
Aug 2019	1367	0.8	6.2	229	51
Sep 2019	2137	1.4	9.2	297	55
Oct 2019	5352	2.3	13.2	1028	74
TOTAL	35842	-	-	11675	637
AVERAGE	2986.8	1.9	11.8	972.9	53.1

## ###Freight

Month	EB Freight Tons	WB Freight Tons	Total Freight	EB Freight %	WB Freight %
Nov 2018	93278	223361	316640	29.5	70.5
Dec 2018	71575	83742	155317	46.1	53.9
Jan 2019	81765	228122	309886	26.4	73.6
Feb 2019	80540	135572	216113	37.3	62.7
Mar 2019	86502	104160	190662	45.4	54.6
Apr 2019	86278	71227	157505	54.8	45.2

May 2019	85927	83228	169155	50.8	49.2
Jun 2019	176389	142159	318548	55.4	44.6
Jul 2019	89515	60126	149641	59.8	40.2
Aug 2019	100384	84516	184900	54.3	45.7
Sep 2019	98378	104905	203283	48.4	51.6
Oct 2019	141637	238961	380597	37.2	62.8
TOTAL	1192168	1560079	2752247	_	-
AVERAGE	99347.3	130006.6	229353.9	45.4	54.6